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Example of Elementary and Enhanced Surveillance
Detailed Requirements

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SUMMARY

This document presents a document containing detailed requirements for the implementation of Elementary and Enhanced Surveillance. As such, this document partially addresses SC-209 Action Item 2-6 by providing possible input for ELS/EHS requirements.

The document presented has multiple areas highlighted that refer to Appendix B. All of these reference areas will need to be updated with the appropriate reference in Appendix B of the proposed RTCA DO-181D Appendix B.

Members of RTCA SC-209 and Eurocae WG-49 are invited to review the attached and comment in regards to the requirements. Particularly, comments are solicited in regards to whether or not the requirements are too detailed, or insufficient.

It is hoped that the requirements can be modified as needed and then incorporated into DO-181D as an appendix providing detailed requirements for Elementary and Enhanced Surveillance.

Once tentative agreement is reached on the application of the requirements, detailed test procedures are also available for working group review after some minor clean up.

1. MODE-S TRANSPONDER ELEMENTARY AND ENHANCED SURVEILLANCE

1.1. INTRODUCTIONS

DFS Deutsche Flugsicherung (German Flight Services) AIC IFR 13 AUG 98, paragraph 5.5.1.1 originally specified the requirement to implement Enhanced Surveillance on all new aircraft by 1 January 2001. Note that this paragraph specifically requires "DAP Capability (Enhanced Surveillance Functionality, which includes Basic Functionality)". This statement indicates that the DFS interprets DAP capability to include Enhanced Surveillance. DFS AIC IFR 15/00, dated 30 November 2000, paragraph 2.a) then moved the requirements for DAP capability on all aircraft with effect from 31 March 2003.

Pursuant to the requirements mandated as described in the above paragraph, the need arises to provide Enhanced Surveillance capability as soon as possible. Briefly, Enhanced Surveillance capability is comprised of the capability of providing Basic or Elementary Surveillance and the servicing of BDS registers 4,0 / 5,0 / and 6,0 in accordance with the Ground Initiated Comm.-B (GICB) protocols specified in RTCA DO-181C.

Further inspection of the requirements indicates that there is considerable interleaving between what is necessary to implement Elementary Surveillance functions ("SI" codes and Flight Identification servicing) and Enhanced Surveillance. Consequently, the following sections of this document have been modified to provide detailed requirements necessary to establish Elementary ("SI" and Flight Ident only) and Enhanced Surveillance in the Mode-S transponder. The following sections are presented in a linear manner in order to be usable by placing most of the Elementary and Enhanced Surveillance requirements in one section. It should be noted that the following sections refer to the main body SRS requirements as well as to [Appendix B](#).

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2. DETAILED ELEMENTARY SURVEILLANCE REQUIREMENTS

2.1. GROUND INITIATED COMM.-B

Commentary: *The Ground Initiated Comm.-B requirements provided in this section are included to provide continuity to understanding the implementation of Elementary and Enhanced surveillance. As such, it provides the baseline for all Comm.-B Data Selector (BDS) register extraction by an interrogator.*

The Mode-S Transponder **shall** support extraction of BDS Registers 1,7 / 1,8 -through- 1,C / 2,0 / 2,1 / 4,0 / 5,0 / 5,F and 6,0 using the Ground Initiated Comm.-B Protocols in accordance RTCA Document No. DO-181C section 2.2.17.1.12.3.

2.2. SURVEILLANCE IDENTIFIER ("SI") CODE REQUIREMENTS

2.2.1. MOPs / ICAO REQUIREMENTS RELEVANT TO "SI"

The Mode-S Transponder **shall** support Surveillance Identifier ("SI") codes in accordance with the following sections in RTCA Document No. DO-181C.

- a. RTCA Document No. DO-181C, section 2.2.14.4., "DI" Designator, Identification Field
- b. RTCA Document No. DO-181C, section 2.2.14.4., "II" Interrogator Identification Field
- c. RTCA Document No. DO-181C, section 2.2.14.4.22., "PI" Parity / Interrogator Identity
- d. RTCA Document No. DO-181C, section 2.2.14.4.28., "SD" Special Designator and "IIS", Subfield in "SD"
- e. RTCA Document No. DO-181C, section 2.2.14.4.35., "CL" Code Label
- f. RTCA Document No. DO-181C, section 2.2.14.4.36., "IC" Interrogator Code
- g. RTCA Document No. DO-181C, section 2.2.14.4.38., "SI" Surveillance Identifier
- h. RTCA Document No. DO-181C, section 2.2.16.2.1., Basic Mode-S Error Protection
- i. RTCA Document No. DO-181C, section 2.2.16.2.5., "Multisite Lockout Protocol"
- j. RTCA Document No. DO-181C, section 2.2.16.2.6.1., "Acquisition Squitter"
- k. RTCA Document No. DO-181C, section 2.2.16.2.6.1., "Extended Squitter Format (DF=17)"
- l. RTCA Document No. DO-181C, section 2.2.16.2.9., "All-Call Reply Protocol"

2.2.2. DECLARATION OF CAPABILITY IN BDS 1,0

See subparagraph 3.1.1.c.(4) of this appendix.

2.3. FLIGHT IDENTIFICATION AND AIRCRAFT REGISTRATION REQUIREMENTS

2.3.1. FLIGHT IDENTIFICATION GICB EXTRACTION PROTOCOL

2.3.1.1. FLIGHT IDENTIFICATION (AIRCRAFT REGISTRATION) REPORTING

The Mode-S Transponder **shall** support Flight Identification and Aircraft Registration reporting in accordance with RTCA Document No. DO-181C, section 2.2.17.1.13.

REFERENCE: RTCA Document No. DO-181C, section 2.2.17.1.13.a and b.

2.3.2. FLIGHT IDENTIFICATION CHANGE ANNUNCIATION

If the aircraft identification reported in the "AIS" subfield is changed in flight (i.e., during a power-on cycle) then the transponder **shall** report the new aircraft identification to the ground in accordance with RTCA Document No. DO-181C, section 2.2.17.1.13.e

by use of the Comm.-B Broadcast Message protocol (see RTCA DO-181C, 2.2.17.1.12.4.1).

REFERENCE: RTCA Document No. DO-181C, section 2.2.17.1.13.e, and 2.2.17.1.12.4.1.

2.3.3. BDS 2,0 __ AIRCRAFT IDENTIFICATION AND DATA SOURCES

2.3.3.1. PURPOSE AND DEFINITION

Appendix B, section 2.7.32 provides full definition of BDS 2,0. The same section provides full definition of the ARINC data words used to provide data for insertion into BDS 2,0.

The Mode-S transponder *shall* comply with all constraints and requirements for servicing BDS 2,0 that are expressed in Appendix B, section 2.7.32.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-32. and Appendix B, sec. 2.7.32 of this document.

REFERENCE: ARINC-718A, Attachment 4.

2.3.3.2. DEFINITION OF AIRCRAFT REGISTRY DATA

Appendix B, section 2.7.33 provides full definition of BDS 2,1.

The Mode-S transponder *shall* comply with all constraints and requirements for servicing BDS 2,1 that are expressed in Appendix B, section 2.7.33 for BDS 2,1.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-33. and Appendix B, sec. 2.7.33 of this document.

REFERENCE: ARINC-718A, Attachment 4.

2.3.4. FLIGHT IDENTIFICATION AND / OR AIRCRAFT REGISTRATION DATA USAGE

2.3.4.1. ICAO GUIDELINES (i.e., REQUIREMENTS)

Use of flight identification or Aircraft Registration Data in BDS 0,8 and BDS 2,0 *shall* comply with the following guidelines:

- a. In accordance with the intent of ICAO Annex 10, Volume IV, Section 3.1.2.9, if Flight identification data (Labels 233 - 237, respectively or Label 360 for block transfer data) is available (i.e., proper labels received and SSM is not set to No Computed Data (NCD)) at anytime during unit operation, then flight identification data *shall* be inserted into the character subfields of registers 0,8 HEX and 2,0 HEX.
- b. If Flight Identification data is NOT available (i.e., no labels received or SSM set to NCD) then Aircraft Registration *shall* be inserted into the character subfields of registers 0,8 HEX and 2,0 HEX. On certain airframe configurations Aircraft Registration data may be provided within ARINC-429 Labels "301" -through- "303". (see [Appendix B, section 2.7.33.](#)).
- c. If Flight Identification data has been entered into registers 0,8 HEX and 2,0 HEX and then becomes NOT available, then the character subfields of the registers *shall* be set to all **ZERO**'s.
- d. In all of the above cases, encoding of the character subfields in registers 0,8 HEX and 2,0 HEX *shall* conform to ICAO Annex 10, Volume IV, section 3.1.2.9, where:

- All characters will be left justified prior to encoding the Character fields.
- Characters will be coded consecutively without intervening SPACE codes.
 - Any unused character spaces at the end of the subfield should contain a SPACE character code.
- Any extra characters will be truncated.

REFERENCE: ICAO Annex 10, Volume IV, section 3.1.2.9.

2.3.4.2. AIRCRAFT REGISTRATION __ ADDITIONAL USAGE

- a. If valid Aircraft Registration (label "301" -through- "303") data is available, then the data *shall* be used to fill the Characters in BDS 2,1, "Aircraft and Airline Registration Markings" as shown in [Appendix B, section 2.7.33](#):
- b. There is currently no way to provide the transponder with ICAO Airline Registration marking. Therefore, bits 44 -through- 56 of BDS 2,1 *shall* be set to **zero**.
- c. When BDS 2,1 is being serviced with Aircraft Registration data, the BDS 2,1 register *shall* be available for GICB Extraction as per section 2.1. of this document.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-33. and [Appendix B, sec. 2.7.33](#) of this document.

REFERENCE: ARINC-718A, Attachment 4.

2.3.4.2.1. BDS 2,1 __ UPDATE RATES

- a. The minimum update rate at which BDS 2,1 *shall* be reloaded with valid data is 15.0 seconds.
(Effectively, BDS 2,1 must be updated every 15.0 seconds or sooner).
- b. If BDS 2,1 cannot be updated within the 15.0 second timeframe, then the contents of BDS 2,1 *shall* be set to ZERO and:
 - (1). Bit 24 of BDS 1,8 *shall* not change state if BDS 2,1 has been properly serviced during the power-on cycle. If BDS 2,1 has not been properly serviced during the

power on cycle, then bit 24 of BDS 1,8 must be verified as being set to ZERO.
(see section 3.3 of this appendix)

- c. The time between availability of data that causes a change in BDS 2,1 and the time that the change is made to BDS 2,1 *shall* be less than the minimum update rate specified as 15.0 seconds.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Section 2.1, 2.1.1., and 2.2.2.

2.3.5. FLIGHT IDENTIFICATION OR AIRCRAFT REGISTRATION DECLARATION OF CAPABILITY

2.3.5.1. IN BDS 1,0 __ DATA LINK CAPABILITY REPORT

Refer to Appendix B, Section 2.7.16 for full definition of BDS 1,0.

Servicing of BDS Register 2,0 requires the updating of BDS 1,0 as follows:

- a. BDS Register 1,0 (Data Link Capability Report) bit **33** *shall* be set to "1" if the transponder is receiving any data from the Aircraft installation with which to service BDS 2,0 with Flight Identification or Aircraft Registration data as provided in the respective sections for each BDS register in the subsequent sections of this document.

Note that this requirement is not established by the transponder LRU own capability to service BDS 2,0. Rather, it is established by the Aircraft installation capability to provide the transponder with the appropriate data with which to then service BDS 2,0.

- b. BDS Register 1,0 (Data Link Capability Report) bit **33** *shall* be set to "0" if the transponder is receiving no data from the Aircraft installation that could be used to properly service BDS 2,0.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-16.

2.3.5.2. IN BDS 1,7 __ COMMON USAGE GICB CAPABILITY REPORT

Refer to [Appendix B, section 2.7.23](#) for full definition of BDS 1,7.

The Mode-S transponder *shall* comply with all constraints and notes provided in [Appendix B, section 2.7.23](#) for BDS 1,7.

2.3.5.2.1. FLIGHT IDENTIFICATION SERVICING

- a. BDS Register 1,7 bit **7** *shall* be set to "1" if the transponder is receiving either Aircraft Identification (also referred to as Flight Identification as specified in the Flight Plan) or Aircraft Registration (which should be coupled to the Mode-S 24-bit Address) data in the Aircraft installation.

Note that this requirement is not established by the transponder LRU own capability to service BDS 2,0. Rather, it is established by the Aircraft installation capability to provide the transponder with the appropriate data with which to then service BDS 2,0.

- b. BDS Register 1,7 bit **7** *shall* be set to "0" if the transponder is receiving no data from the Aircraft installation that could be used to properly service BDS 2,0.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-23. and [Appendix B, sec. 2.7.23](#) of this document.

2.3.5.2.2. AIRCRAFT REGISTRATION SERVICING

- a. BDS Register 1,7 bit **8** *shall* be set to "1" if the transponder is receiving Aircraft Registration (which should be coupled to the Mode-S 24-bit Address) data in the Aircraft installation.

Note that this requirement is not established by the transponder LRU own capability to service BDS 2,1. Rather, it is established by the Aircraft installation capability to provide the transponder with the appropriate data with which to then service BDS 2,1.

- b. BDS Register 1,7 bit **8** *shall* be set to "0" if the transponder is receiving no data from the Aircraft installation that could be used to properly service BDS 2,1.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-23. and Appendix B, sec. 2.7.23 of this document.

2.3.5.3. IN BDS 1,8 -through- 1,C __ MODE-S SPECIFIC SERVICES GICB CAPABILITY REPORT

Refer to Appendix B, section 2.7.24 -through- 2.7.28 for full definition of BDS 1,8 -through- 1,C respectively..

The Mode-S transponder *shall* comply with all constraints and notes provided in Appendix B, section 2.7.24 -through- 2.7.28 for BDS 1,8 -through- 1,C respectively.

2.3.5.3.1. FLIGHT IDENTIFICATION SERVICING

- a. BDS Register 1,8 bit **25** *shall* be set to "1" if the transponder has received either Aircraft Identification (also referred to as Flight Identification as specified in the Flight Plan) or Aircraft Registration (which should be coupled to the Mode-S 24-bit Address) data in the Aircraft Installation during the power on cycle.

Note that this requirement is not established by the Transponder LRU own capability to service BDS 2,0. Rather, it is established by the Aircraft installation capability to provide the transponder with the appropriate data with which to then service BDS 2,0.

Also, note that once BDS Register 1,8 bit **25** has been set to "1" during a particular power on cycle, then it *shall* remain set to "1" for the duration of the power on cycle.

- b. BDS Register 1,8 bit **25** *shall* be set to "0" if the transponder receives no data from the Aircraft installation that could be used to properly service BDS 2,0 during the power on cycle.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-24. and Appendix B, sec. 2.7.24 of this document.

2.3.5.3.2. AIRCRAFT REGISTRATION SERVICING

- a. BDS Register 1,8 bit **24** *shall* be set to "1" if the transponder has received Aircraft Registration (which should be coupled to the Mode-S 24-bit Address) data in the Aircraft Installation during the power on cycle.

Note that this requirement is not established by the Transponder LRU own capability to service BDS 2,1. Rather, it is established by the Aircraft installation capability to provide the transponder with the appropriate data with which to then service BDS 2,1.

Also, note that once BDS Register 1,8 bit **24** has been set to "1" during a particular power on cycle, then it *shall* remain set to "1" for the duration of the power on cycle.

- b. BDS Register 1,8 bit **24** *shall* be set to "0" if the transponder receives no data from the Aircraft installation that could be used to properly service BDS 2,1 during the power on cycle.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-24. and Appendix B, sec. 2.7.24 of this document.

2.3.6. BDS 2,0 __ FLIGHT IDENTIFICATION UPDATE RATES

- a. The minimum update rate at which BDS 2,0 *shall* be reloaded with valid data is 5.0 seconds.

(Effectively, BDS 2,0 must be updated every 5.0 seconds or sooner).

- b. If BDS 2,0 cannot be updated within the 5.0 second timeframe, then the contents of BDS 2,0 *shall* be set to ZERO and:

- (1). Bit **7** of BDS 1,7 *shall* be set to **ZERO**.

- (2). Bit **25** of BDS 1,8 *shall* not change state if BDS 2,0 has been properly serviced during the power-on cycle. If BDS 2,0 has not been properly serviced during the power on cycle, then bit 25 of BDS 1,8 must be verified as being set to ZERO. (see section 2.3.5.3.1 of this appendix)
- c. The time between availability of data that causes a change in BDS 2,0 and the time that the change is made to BDS 2,0 *shall* be less than the minimum update rate specified as 5.0 seconds.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Section 2.1, 2.1.1., and 2.2.2. Also same sections in **Appendix B** of this document.

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3. DETAILED ENHANCED SURVEILLANCE REQUIREMENTS

3.1. DECLARATION OF CAPABILITY IN BDS 1,0

3.1.1. DECLARATION OF BDS 1,0 / 2,0 / 2,1 / 1,7 / 1,8 - 1,C / 4,0 / 5,0 / 5,F / or 6,0 CAPABILITY

- a. BDS Register 1,0 (Data Link Capability Report) bit **25** *shall* be set to "1" if the transponder is receiving any data from the Aircraft installation with which to service BDS 1,0 / 2,0 / 2,1 / 1,7 / 1,8 - 1,C, 4,0 / 5,0 / 5,F or 6,0 (or other BDS registers) as provided in the respective sections for each BDS register in this document.

Note that this requirement is not established by the transponder LRU own capability to service BDS 1,0 / 2,0 / 2,1 / 1,7 / 1,8 - 1,C, 4,0 / 5,0 / 5,F or 6,0 (or other BDS registers). Rather, it is established by the Aircraft installation capability to provide the transponder with the appropriate data with which to then service BDS 1,0 / 2,0 / 2,1 / 1,7 / 1,8 - 1,C, 4,0 / 5,0 / 5,F or 6,0 (or other BDS registers).

- b. BDS Register 1,0 (Data Link Capability Report) bit **25** *shall* be set to "0" if the transponder is receiving no data from the Aircraft installation that could be used to properly service either BDS 1,0 / 2,0 / 2,1 / 1,7 / 1,8 - 1,C, 4,0 / 5,0 / 5,F or 6,0.
- c. When bit **25** is set to **1**, it *shall* indicate that at least one Mode S Specific Service is supported and the particular capability reports *shall* be checked.

Effectively, the transponder must update the following BDS 1,0 bits where applicable:

- (1). Bit **25** as provided in subparagraphs a and b above.
- (2). Bit **33** as provided in section 2.3.5.1 of this appendix
- (3). Bit **36** as provided in section 3.1.2. of this appendix
- (4). Bit **35** when capable of servicing Surveillance Identifier (SI) capability.
Bit **35**: = **0** if no surveillance identifier code capability is available
= **1** if capable of surveillance identifier code

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-16. and Appendix B, sec. 2.7.16 of this document.

3.1.2. DECLARATION OF BDS 1,7 CAPABILITY

- a. BDS Register 1,0 (Data Link Capability Report) bit **36** *shall* be toggled (i.e., changed from "0" to "1", or from "1" to "0") each time that the Common Usage GICB Capability Report (BDS code 1,7) is changed.
- b. To avoid the generation of too many broadcast capability report changes, BDS code 1,7 *shall* be sampled at approximately one minute intervals to check for changes that may require the toggling of bit **36** as discussed in subparagraph a.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-16. and Appendix B, sec. 2.7.16 of this document.

3.1.3. DATA LINK CAPABILITY REPORT (BDS 1,0) FULL DEFINITION

Refer to [Appendix B, Section 2.7.16](#) for full definition of BDS 1,0.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-16. and [Appendix B, sec. 2.7.16](#) of this document.

3.1.4. MINIMUM UPDATE RATE OF BDS 1,0

- a. The minimum update rate at which BDS 1,0 *shall* be reloaded with valid data is <4.0 seconds.
(Effectively, BDS 1,0 must be updated every 4.0 seconds or sooner).
- b. BDS 1,0 *shall* be updated within one second of the data changing and at least every four seconds thereafter.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Section 2.1, 2.1.1., and 2.2.2. Also same sections in [Appendix B](#) of this document.

3.2. BDS 1,7 __ COMMON USAGE GICB CAPABILITY REPORT

3.2.1. BDS 1,7 __ PURPOSE AND DEFINITION

Refer to [Appendix B, section 2.7.23](#) for full definition of BDS 1,7.

The Mode-S transponder *shall* comply with all constraints and notes provided in [Appendix B, section 2.7.23](#) for BDS 1,7.

3.2.2. ENHANCED SURVEILLANCE SERVICING REQUIREMENTS

3.2.2.1. REQUIRED SERVICING ASSOCIATED WITH BDS 2,0

Refer to section 2.3.5.2.1 of this appendix, where requirements have previously been provided.

3.2.2.2. REQUIRED SERVICING ASSOCIATED WITH BDS 2,1

Refer to section 2.3.5.2.2 of this appendix, where requirements have previously been provided.

3.2.2.3. REQUIRED SERVICING ASSOCIATED WITH BDS 4,0

- a. BDS Register 1,7 bit 9 *shall* be set to "1" if the transponder is receiving either Selected Altitude, FMS Selected Altitude, or Barometric Pressure Setting data in the Aircraft installation. (Refer to Section 3.4 of this appendix for full definition of BDS 4,0)
Note that this requirement is not established by the transponder LRU own capability to service BDS 4,0. Rather, it is established by the Aircraft installation capability to provide the transponder with the appropriate data with which to then service BDS 4,0.
- b. BDS Register 1,7 bit 9 *shall* be set to "0" if the transponder is receiving no data from the Aircraft installation that could be used to properly service BDS 4,0.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-23. and [Appendix B, sec. 2.7.23](#) of this document.

3.2.2.4. REQUIRED SERVICING ASSOCIATED WITH BDS 5,0

- a. BDS Register 1,7 bit **16** *shall* be set to "1" if the transponder is receiving either Roll Angle, True Track Angle, Ground Speed, Track Angle Rate, or True Airspeed data in the Aircraft installation. (Refer to Section 3.5 for full definition of BDS 5,0)

Note that this requirement is not established by the transponder LRU own capability to service BDS 5,0. Rather, it is established by the Aircraft installation capability to provide the transponder with the appropriate data with which to then service BDS 5,0.

- b. BDS Register 1,7 bit **16** *shall* be set to "0" if the transponder is receiving no data from the Aircraft installation that could be used to properly service BDS 5,0.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-23. and Appendix B, sec. 2.7.23 of this document.

3.2.2.5. REQUIRED SERVICING ASSOCIATED WITH BDS 5,F

- a. BDS Register 1,7 bit **23** *shall* be set to "1" if the transponder is receiving Selected Altitude necessary to update BDS 4,0 (see section 3.4) which then requires that BDS 5,F be updated in accordance with section 3.6 of this appendix.

Note that this requirement is not established by the transponder LRU own capability to service BDS 5,F. Rather, it is established by the Aircraft installation capability to provide the transponder with the appropriate data with which to then service BDS 5,F.

- b. BDS Register 1,7 bit **23** *shall* be set to "0" if the transponder is receiving no data from the Aircraft installation that could be used to properly service BDS 5,F.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-23. and Appendix B, sec. 2.7.23 of this document.

3.2.2.6. REQUIRED SERVICING ASSOCIATED WITH BDS 6,0

- a. BDS Register 1,7 bit **24** *shall* be set to "1" if the transponder is receiving either Magnetic Heading, Indicated Airspeed, Mach, Barometric Altitude Rate, or Inertial Vertical Velocity data in the Aircraft installation. (Refer to Section 3.7 for full definition of BDS 6,0)

Note that this requirement is not established by the transponder LRU own capability to service BDS 6,0. Rather, it is established by the Aircraft installation capability to provide the transponder with the appropriate data with which to then service BDS 6,0.

- b. BDS Register 1,7 bit **24** *shall* be set to "0" if the transponder is receiving no data from the Aircraft installation that could be used to properly service BDS 6,0.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-23. and Appendix B, sec. 2.7.23 of this document.

3.2.3. MINIMUM UPDATE RATE OF BDS 1,7

- a. The minimum update rate at which BDS 1,7 *shall* be reloaded with valid data is 5.0 seconds.

That is, that BDS 1,7 shall be updated at least once every 5.0 seconds.

- b. The time between availability of data that causes a change in BDS 1,7 and the time that the change is made to BDS 1,7 *shall* be less than the minimum update rate specified as 5.0 seconds.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Section 2.1, 2.1.1., and 2.2.2. Also same sections in **Appendix B** of this document.

3.3. BDS 1,8 -to- 1,C __ MODE-S SPECIFIC SERVICES GICB CAPABILITY

3.3.1. PURPOSE AND DEFINITION

Refer to **Appendix B, section 2.7.24 -through- 2.7.28** for full definition of BDS 1,8 -through- 1,C respectively..

The Mode-S transponder *shall* comply with all constraints and notes provided in **Appendix B, section 2.7.24 -through- 2.7.28** for BDS 1,8 -through- 1,C respectively.

3.3.2. ENHANCED SURVEILLANCE SERVICING REQUIREMENTS

3.3.2.1. REQUIRED SERVICING ASSOCIATED WITH BDS 1,7

- a. BDS Register 1,8 bit **34** *shall* be set to "1" if the transponder is required to service any part of BDS 1,7 as provided in section 3.2 of this appendix.

Note that this requirement is not established by the Transponder LRU own capability to service BDS 1,7. Rather, it is established by the Aircraft installation capability to provide the transponder with the appropriate data of which processing would result in the need to update BDS 1,7.

Also, note that once BDS Register 1,8 bit **34** has been set to "1" during a particular power on cycle, then it *shall* remain set to "1" for the duration of the power on cycle.

- b. BDS Register 1,8 bit **34** *shall* be set to "0" if the transponder receives no data from the Aircraft installation that could result in the need to service BDS 1,7 as provided in section 3.2 of this appendix.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-24. and **Appendix B, sec. 2.7.24** of this document.

3.3.2.2. REQUIRED SERVICING ASSOCIATED WITH BDS 1,8

- a. BDS Register 1,8 bit **33** *shall* be set to "1" if the transponder is required to service any part of BDS 1,8 as provided in section 3.3.

Note that this requirement is not established by the Transponder LRU own capability to service BDS 1,8. Rather, it is established by the Aircraft installation capability to provide the transponder with the appropriate data of which processing would result in the need to update BDS 1,8.

Also, note that once BDS Register 1,8 bit **33** has been set to "1" during a particular power on cycle, then it *shall* remain set to "1" for the duration of the power on cycle.

- b. BDS Register 1,8 bit **33** *shall* be set to "0" if the transponder receives no data from the Aircraft installation that could result in the need to service BDS 1,8 as provided in section 3.3 of this appendix.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-24. and **Appendix B, sec. 2.7.24** of this document.

3.3.2.3. REQUIRED SERVICING ASSOCIATED WITH BDS 1,9

- a. BDS Register 1,8 bit **32** *shall* be set to "1" if the transponder is required to service any part of BDS 1,9 as provided in section 3.3 of this appendix.

Note that this requirement is not established by the Transponder LRU own capability to service BDS 1,9. Rather, it is established by the Aircraft installation capability to provide

the transponder with the appropriate data of which processing would result in the need to update BDS 1,9.

Also, note that once BDS Register 1,8 bit **32** has been set to "1" during a particular power on cycle, then it *shall* remain set to "1" for the duration of the power on cycle.

- b. BDS Register 1,8 bit **32** *shall* be set to "0" if the transponder receives no data from the Aircraft installation that could result in the need to service BDS 1,9 as provided in section 3.3 of this appendix.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-24. and Appendix B, sec. 2.7.24 of this document.

3.3.2.4. REQUIRED SERVICING ASSOCIATED WITH BDS 2,0

Refer to section 2.3.5.3.1 of this appendix.

3.3.2.5. REQUIRED SERVICING ASSOCIATED WITH BDS 2,1

Refer to section 2.3.5.3.2 of this appendix.

3.3.2.6. REQUIRED SERVICING ASSOCIATED WITH BDS 4,0

- a. BDS Register 1,9 bit **49** *shall* be set to "1" if the transponder has received either Selected Altitude, FMS Selected Altitude, or Barometric Corrected Altitude data in the Aircraft Installation during the power on cycle. (Refer to section 3.4 of this appendix for full definition of BDS 4,0).

Note that this requirement is not established by the Transponder LRU own capability to service BDS 4,0. Rather, it is established by the Aircraft installation capability to provide the transponder with the appropriate data with which to then service BDS 4,0.

Also, note that once BDS Register 1,9 bit **49** has been set to "1" during a particular power on cycle, then it *shall* remain set to "1" for the duration of the power on cycle.

- b. BDS Register 1,9 bit **49** *shall* be set to "0" if the transponder receives no data from the Aircraft installation that could be used to properly service BDS 4,0 during the power on cycle.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-24. and Appendix B, sec. 2.7.24 of this document.

3.3.2.7. REQUIRED SERVICING ASSOCIATED WITH BDS 5,0

- a. BDS Register 1,9 bit **33** *shall* be set to "1" if the transponder has received either Roll Angle, True Track Angle, Ground Speed, Track Angle Rate, or True Airspeed data in the Aircraft installation during the power on cycle. (Refer to Section 3.5 of this appendix for full definition of BDS 5,0)

Note that this requirement is not established by the Transponder LRU own capability to service BDS 5,0. Rather, it is established by the Aircraft installation capability to provide the transponder with the appropriate data with which to then service BDS 5,0.

Also, note that once BDS Register 1,9 bit **33** has been set to "1" during a particular power on cycle, then it *shall* remain set to "1" for the duration of the power on cycle.

- b. BDS Register 1,9 bit **33** *shall* be set to "0" if the transponder receives no data from the Aircraft installation that could be used to properly service BDS 5,0 during the power on cycle.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-24. and Appendix B, sec. 2.7.24 of this document.

3.3.2.8. REQUIRED SERVICING ASSOCIATED WITH BDS 5,F

- a. BDS Register 1,9 bit **18** *shall* be set to "1" if the transponder is required to service any part of BDS 5,F as provided in section 3.6 of this appendix.

Note that this requirement is not established by the Transponder LRU own capability to service BDS 5,F. Rather, it is established by the Aircraft installation capability to provide the transponder with the appropriate data of which processing would result in the need to update BDS 5,F.

Also, note that once BDS Register 1,9 bit **18** has been set to "1" during a particular power on cycle, then it *shall* remain set to "1" for the duration of the power on cycle.

- b. BDS Register 1,9 bit **18** *shall* be set to "0" if the transponder receives no data from the Aircraft installation that could result in the need to service BDS 5,F as provided in section 3.6 of this appendix.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-24. and Appendix B, sec. 2.7.24 of this document.

3.3.2.9. REQUIRED SERVICING ASSOCIATED WITH BDS 6,0

- a. BDS Register 1,9 bit **17** *shall* be set to "1" if the transponder has received either Magnetic Heading, Indicated Airspeed, Mach, Barometric Altitude Rate, or Inertial Vertical Velocity data in the Aircraft installation during the power on cycle. (Refer to Section 3.5 of this appendix for full definition of BDS 6,0)

Note that this requirement is not established by the Transponder LRU own capability to service BDS 6,0. Rather, it is established by the Aircraft installation capability to provide the transponder with the appropriate data with which to then service BDS 5,0.

Also, note that once BDS Register 1,9 bit **17** has been set to "1" during a particular power on cycle, then it *shall* remain set to "1" for the duration of the power on cycle.

- b. BDS Register 1,9 bit **17** *shall* be set to "0" if the transponder receives no data from the Aircraft installation that could be used to properly service BDS 6,0 during the power on cycle.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-24. and Appendix B, sec. 2.7.24 of this document.

3.3.3. MINIMUM UPDATE RATE OF BDS 1,8 -to- 1,C

- a. The minimum update rate at which BDS 1,8 and/or 1,9 *shall* be reloaded with valid data is 5.0 seconds.

That is, that BDS 1,8 and/or 1,9 shall be updated at least once every 5.0 seconds.

- b. The time between availability of data that causes a change in BDS 1,8 and/or BDS 1,9 and the time that the change is made to BDS 1,8 and/or BDS 1,9 *shall* be less than the minimum update rate specified as 5.0 seconds.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Section 2.1, 2.1.1., and 2.2.2. Also same sections in Appendix B of this document.

3.4. BDS 4,0 __ AIRCRAFT INTENTION

3.4.1. PURPOSE AND DEFINITION

Appendix B, section 2.7.64 provides full definition of BDS 4,0. The same section provides full definition of the ARINC data words used to provide data for insertion into BDS 4,0.

The transponder *shall* comply will all constraints and requirements for servicing BDS 4,0 that are expressed in Appendix B, section 2.7.64.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-64. and Appendix B, sec. 2.7.64 of this document.

3.4.2. BDS 4,0 __ DATA REQUIREMENTS

3.4.2.1. SELECTED ALTITUDE FROM ALTITUDE CONTROL PANEL

- a. The transponder *shall* process Selected Altitude From Altitude Control Panel (Mode Control Panel/Flight Control Unit or equivalent equipment) data from on-board aircraft data sources as provided in [Appendix B, section 2.7.64, Note-1](#) of the BDS 4,0 definition table and format the data into bits 2 -through- 13 of the BDS 4,0 "MB" field as shown in that table.
- b. The data loaded into the "MB" field *shall* be rounded so as to preserve accuracy of the source data within +/- 1/2 LSB. (see section 3.5.1.9 of this appendix for an example of the rounding process)
- c. Status Bit 1 *shall* be set to "1" whenever valid data is available in bits 2 -through- 13.
- d. Status Bit 1 *shall* be set to "0" whenever there is no valid data with which to fill bits 2 -through- 13.
- e. Bits 2 -through- 13 *shall* be set to "0" whenever there is no valid data with which to fill the bits.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-64. and [Appendix B, sec. 2.7.64](#) of this document.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Section 2.2.1. Also same sections in [Appendix B](#) of this document.

3.4.2.2. FMS SELECTED ALTITUDE

- a. The transponder *shall* process FMS Selected Altitude data from on-board aircraft data sources as provided in [Appendix B, section 2.7.64, Note T-1](#) of the BDS 4,0 definition table and format the data into bits 15 -through- 26 of the BDS 4,0 "MB" field as shown in that table.
- b. The data loaded into the "MB" field *shall* be rounded so as to preserve accuracy of the source data within +/- 1/2 LSB. (see section 3.5.1.9 of this appendix) for an example of the rounding process)
- c. Status Bit 14 *shall* be set to "1" whenever valid FMS Selected Altitude data is available in bits 15 -through- 26.
- d. If FMS Selected Altitude data is not available for insertion into bits 15 -through- 26, Status Bit 14 *shall* be set to "0".
- e. If FMS Selected Altitude data is not available for insertion into bits 15 -through- 26, bits 15 -through- 26 *shall* be set to "0".

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-64. and [Appendix B, sec. 2.7.64](#) of this document.

3.4.2.3. BAROMETRIC CORRECTION

- a. The transponder *shall* process Barometric Correction data from on-board aircraft data sources as provided in [Appendix B, section 2.7.64, Note T-2](#) of the BDS 4,0 definition table. Further processing of the input Barometric Correction data is needed as follows:
 - (1). Note that the Barometric Correction data received is in **BCD** format and must be converted to **Binary** format prior to encoding data into BDS 4,0. Tentative information regarding BCD to Binary Conversion and final mapping of the data into BDS 4,0 is provided in the following Note:

Note: *Barometric Correction BCD -to- BINARY Conversion Method*
Consider input of 1085.9 millibars in BCD data.

Multiply by 10 to give the BCD count of 0.1 increments needed to represent the input data.
Yields: 10859

10859/2	=	5429	-	1	
5429/2	=	2714	-	1	
2714/2	=	1357	-	0	
1357/2	=	678	-	1	
678/2	=	339	-	0	
339/2	=	169	-	1	
169/2	=	84	-	1	
84/2	=	42	-	0	
42/2	=	21	-	0	
21/2	=	10	-	1	
10/2	=	5	-	0	
5/2	=	2	-	1	
2/2	=	1	-	0	
1/2	=	0	-	1	== 0010 1010 0110 1011 Hex == 2A6B Hex == 10859 Decimal

Start:	0001 0000 1000 0101 1001	10859	BCD
Rotate R:	0000 1000 0100 0010 1100	1	
Add	<u>0000 1101 0000 0000 1101</u>		Add "0D" Hex to each nibble that has the MSB of the nibble set to "1". Disregard the Carry.
	0000 0101 0100 0010 1001	05429	
Rotate R:	0000 0010 1010 0001 0100	1	
Add	<u>0000 0000 1101 0000 0000</u>		
	0000 0010 0111 0001 0100	02714	
Rotate R:	0000 0001 0011 1000 1010	0	
Add	<u>0000 0000 0000 1101 1101</u>		
	0000 0001 0011 0101 0111	01357	
Rotate R:	0000 0000 1001 1010 1011	1	
Add	<u>0000 0000 1101 1101 1101</u>		
	0000 0000 0110 0111 1000	00678	
Rotate R:	0000 0000 0011 0011 1100	0	
Add	<u>0000 0000 0000 0000 1101</u>		
	0000 0000 0011 0011 1001	00339	
Rotate R:	0000 0000 0001 1001 1100	1	
Add	<u>0000 0000 0000 1101 1101</u>		
	0000 0000 0001 0110 1001	00169	
Rotate R:	0000 0000 0000 1011 0100	1	
Add	<u>0000 0000 0000 1101 0000</u>		
	0000 0000 0000 1000 0100	00084	
Rotate R:	0000 0000 0000 0100 0010	0	00042
Rotate R:	0000 0000 0000 0010 0001	0	00021
Rotate R:	0000 0000 0000 0001 0000	1	00010
Rotate R:	0000 0000 0000 0000 1000	0	
Add	<u>0000 0000 0000 0000 1101</u>		
	0000 0000 0000 0000 0101	00005	
Rotate R:	0000 0000 0000 0000 0010	1	00002
Rotate R:	0000 0000 0000 0000 0001	0	00001
Rotate R:	0000 0000 0000 0000 0000	1	00000

Binary Equivalent == 0010 1010 0110 1011 = 2A6B Hex = 10859 Decimal

Next:

Establish Equivalent of 800.0 millibars having 0.1 resolution

Effectively, establish a count of 8000 millibars in binary: The value is **1F40** Hex

Establish 2's complement of **1F40** Hex as **E0C0** Hex.

Now, Effectively subtract 8000 from the Binary Equivalent above as follows

Binary Equivalent	== 0010 1010 0110 1011	= 2A6B Hex	= 10859 Decimal
Add Neg. 800.0 mb	== <u>1110 0000 1100 0000</u>	= E0C0 Hex	= -8000 millibars
Resultant Sum:	0000 1011 0010 1011	= 0B2B Hex	= 2859 Decimal

Map the Resultant Data into Bits 28 -through- 39 of BDS 4,0 as follows:

	M										L
	S										S
	B										B
Bit:	2	2	3	3	3	3	3	3	3	3	3
	8	9	0	1	2	3	4	5	6	7	8
Data:	1	0	1	1	0	0	1	0	1	0	1

- (2). Note that the encoding that is provided in [Appendix B, section 2.7.64](#) BDS 4,0 for Barometric Pressure Setting represents the input Barometric Correction data MINUS 800 millibars (mb). See [Appendix B, Section 2.7.64](#), BDS 4,0 definition, Note 5. Also, note that this 800 millibar correction has been taken into account in the BCD -to- BINARY conversion performed in the Note given in 3.4.2.3.a.(1).
- b. The data loaded into the "MB" field *shall* be the Barometric Correction MINUS 800 millibars (mb) that has been converted to BINARY data in a manner that is consistent and equivalent with the BCD -to- BINARY conversion performed in the Note given in 3.4.2.3.a.(1).
- c. Status Bit **27** *shall* be set to "1" whenever valid data is available in bits **28** -through- **39**, and the conditions given in 3.4.2.3.d are not applicable.
- d. Status Bit **27** *shall* be set to "0" whenever:
 - (1). There is no valid data with which to fill bits 28 -through- 39.
 - (2). The input Barometric Correction data is less than 800 millibars (mb).
Note: *this would result in a negative Barometric Pressure Setting after subtracting 800 millibars (mb) and doing the BCD -to- BINARY conversion.*
 - (3). The input Barometric Correction data is greater than 1209.5 millibars (mb).
- e. Bits **28** -through- **39** *shall* be set to "0" whenever there is no valid data with which to fill the bits.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-64. and [Appendix B, sec. 2.7.64](#) of this document.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Section 2.2.1. Also same sections in [Appendix B](#) of this document.

3.4.2.4. STATUS OF ALTITUDE CONTROL PANEL MODE BITS

Appropriate sources and/or labels for providing Altitude Control Panel (MCP / FCU) Mode status have not been agreed to universally in the industry: **Therefore:**

Until further definition, Bit **48** of BDS 4,0 "MB" field *shall* be set to "0".

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-64. and [Appendix B, sec. 2.7.64](#) of this document.

3.4.2.5. VERTICAL NAVIGATION MODE

Appropriate sources and/or labels for providing Vertical Navigation (VNAV) Mode status have not been agreed to universally in the industry: **Therefore:**

Until further definition, Bit **49** of BDS 4,0 "MB" field *shall* be set to "0".

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-64. and Appendix B, sec. 2.7.64 of this document.

3.4.2.6. ALTITUDE HOLD BIT

Appropriate sources and/or labels for providing Altitude Hold status have not been agreed to universally in the industry: **Therefore:**

Until further definition, Bit **50** of BDS 4,0 "MB" field *shall* be set to "0".

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-64. and Appendix B, sec. 2.7.64 of this document.

3.4.2.7. APPROACH MODE BIT

Appropriate sources and/or labels for providing Approach Mode status have not been agreed to universally in the industry: **Therefore:**

Until further definition, Bit **51** of BDS 4,0 "MB" field *shall* be set to "0".

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-64. and Appendix B, sec. 2.7.64 of this document.

3.4.2.8. RESERVED BITS

Bits **52** and **53** of BDS 4,0 "MB" field *shall* be set to "0".

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-64. and Appendix B, sec. 2.7.64 of this document.

3.4.2.9. STATUS OF TARGET ALTITUDE STATUS BIT

Appropriate sources and/or labels for providing Target Altitude status or source have not been agreed to universally in the industry: **Therefore:**

Until further definition, Bit **54** of BDS 4,0 "MB" field *shall* be set to "0".

Note: In order to set bits 54, 55 and 56 appropriately, the transponder must receive information from the Auto Pilot, Vertical Navigation Control, or Flight Management System in order to establish which system has control of the aircraft vertical profile. Until such data is defined and provided, the transponder must set these bits to ZERO.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-64. and Appendix B, sec. 2.7.64 of this document.

3.4.2.10. TARGET ALTITUDE SOURCE BITS

Appropriate sources and/or labels for providing Target Altitude status or source have not been agreed to universally in the industry: **Therefore:**

Until further definition, bit **55** and **56** of BDS 4,0 "MB" field *shall* be set to "0".

Note: In order to set bits 54, 55 and 56 appropriately, the transponder must receive information from the Auto Pilot, Vertical Navigation Control, or Flight Management System in order to establish which system has control of the aircraft vertical profile. Until such data is defined and provided, the transponder must set these bits to ZERO.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-64. and Appendix B, sec. 2.7.64 of this document.

3.4.3. MINIMUM UPDATE RATE OF BDS 4,0

- a. The minimum update rate at which BDS 4,0 *shall* be reloaded with valid data is 1.0 second.

That is, that BDS 4,0 shall be updated at least once every 1.0 second.

- b. The time between availability of data that causes a change in BDS 4,0 and the time that the change is made to BDS 4,0 **shall** be less than the minimum update rate specified as 1.0 seconds.
- c. If Altitude Control Panel (MCP /FCU) Selected Altitude in BDS 4,0 "MB" field bits **2** -through- **13** cannot be updated with valid data within the 1.0 second update period, then Status Bit **1** **shall** be set to "0".
- d. If FMS Selected Altitude in BDS 4,0 "MB" field bits **15** -through- **26** cannot be updated with valid data within the 1.0 second update period, then Status Bit **14** **shall** be set to "0".
- e. If Barometric Corrected Altitude in BDS 4,0 "MB" field bits **28** -through- **39** cannot be updated with valid data within the 1.0 second update period, then Status Bit **27** **shall** be set to "0".

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-64. and Appendix B, sec. 2.7.64 of this document.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Section 2.1, 2.1.1., and 2.1.2. Also same sections in Appendix B of this document.

3.5. BDS 5,0 __ TRACK AND TURN REPORT

3.5.1. PURPOSE AND DEFINITION

Appendix B, section 2.7.80 provides full definition of BDS 5,0. The same section provides full definition of the ARINC data words used to provide data for insertion into BDS 5,0.

The Mode-S transponder **shall** comply with all constraints and requirements for servicing BDS 5,0 that are expressed in Appendix B, section 2.7.80.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-80. and Appendix B, sec. 2.7.80 of this document.

3.5.2. BDS 5,0 __ DATA REQUIREMENTS

3.5.2.1. ROLL ANGLE

- a. The transponder **shall** process Roll Angle data from on-board aircraft data sources as provided in Appendix B, section 2.7.80, Note T-2 of the BDS 5,0 definition table and format the data into bits **2** -through- **11** of the BDS 5,0 "MB" field as shown in that table.
- b. The data loaded into the "MB" field **shall** be rounded so as to preserve accuracy of the source data within +/- 1/2 LSB.
- c. Status Bit **1** **shall** be set to "1" whenever valid data is available in bits **2** -through- **11**.
- d. Status Bit **1** **shall** be set to "0" whenever there is no valid data with which to fill bits **2** -through- **11**.
- e. Bits **2** -through- **11** **shall** be set to "0" whenever there is no valid data with which to fill the bits.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-80. and Appendix B, sec. 2.7.80 of this document.

3.5.2.2. TRUE TRACK ANGLE

- a. The transponder **shall** process True Track Angle data from on-board aircraft data sources as provided in Appendix B, section 2.7.80, Note T-3 of the BDS 5,0 definition table and format the data into bits **13** -through- **23** of the BDS 5,0 "MB" field as shown in that table.
- b. The data loaded into the "MB" field **shall** be rounded so as to preserve accuracy of the source data within +/- 1/2 LSB.
- c. Status Bit **12** **shall** be set to "1" whenever valid data is available in bits **13** -through- **23**.

- d. Status Bit **12** *shall* be set to "0" whenever there is no valid data with which to fill bits **13** -through- **23**.
- e. Bits **13** -through- **23** *shall* be set to "0" whenever there is no valid data with which to fill the bits.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-80. and Appendix B, sec. 2.7.80 of this document.

3.5.2.3. GROUND SPEED

- a. The transponder *shall* process Ground Speed data from on-board aircraft data sources as provided in Appendix B, section 2.7.80, Note T-4 of the BDS 5,0 definition table and format the data into bits **25** -through- **34** of the BDS 5,0 "MB" field as shown in that table.
- b. The data loaded into the "MB" field *shall* be rounded so as to preserve accuracy of the source data within +/- 1/2 LSB.
- c. Status Bit **24** *shall* be set to "1" whenever valid data is available in bits **25** -through- **34**.
- d. Status Bit **24** *shall* be set to "0" whenever there is no valid data with which to fill bits **25** -through- **34**.
- e. Bits **25** -through- **34** *shall* be set to "0" whenever there is no valid data with which to fill the bits.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-80. and Appendix B, sec. 2.7.80 of this document.

3.5.2.4. TRACK ANGLE RATE

- a. The transponder *shall* process Track Angle Rate data from on-board aircraft data sources as provided in Appendix B, section 2.7.80, Note T-6 of the BDS 5,0 definition table and format the data into bits **36** -through- **45** of the BDS 5,0 "MB" field as shown in that table.
- b. The data loaded into the "MB" field *shall* be rounded so as to preserve accuracy of the source data within +/- 1/2 LSB.
- c. Status Bit **35** *shall* be set to "1" whenever valid data is available in bits **36** -through- **45**.
- d. Status Bit **35** *shall* be set to "0" whenever there is no valid data with which to fill bits **36** -through- **45**.
- e. Bits **36** -through- **45** *shall* be set to "0" whenever there is no valid data with which to fill the bits.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-80. and Appendix B, sec. 2.7.80 of this document.

3.5.2.5. TRUE AIRSPEED (TAS)

- a. The transponder *shall* process True Airspeed (TAS) data from on-board aircraft data sources as provided in Appendix B, section 2.7.80, Note T-7 of the BDS 5,0 definition table and format the data into bits **47** -through- **56** of the BDS 5,0 "MB" field as shown in that table.
- b. The data loaded into the "MB" field *shall* be rounded so as to preserve accuracy of the source data within +/- 1/2 LSB.
- c. Status Bit **46** *shall* be set to "1" whenever valid data is available in bits **47** -through- **56**.
- d. Status Bit **46** *shall* be set to "0" whenever there is no valid data with which to fill bits **47** -through- **56**.
- e. Bits **47** -through- **56** *shall* be set to "0" whenever there is no valid data with which to fill the bits.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-80. and Appendix B, sec. 2.7.80 of this document.

3.5.3. MINIMUM UPDATE RATE OF BDS 5,0

- a. The minimum update rate at which BDS 5,0 *shall* be reloaded with valid data is 1.0 second.
That is, that BDS 5,0 shall be updated at least once every 1.0 second.
- b. The time between availability of data that causes a change in BDS 5,0 and the time that the change is made to BDS 5,0 *shall* be less than the minimum update rate specified as 1.0 seconds.
- c. If Roll Angle data in BDS 5,0 "MB" field bits 2 -through- 11 cannot be updated with valid data within the 1.0 second update period, then Status Bit 1 *shall* be set to "0".
- d. If True Track Angle data in BDS 5,0 "MB" field bits 13 -through- 23 cannot be updated with valid data within the 1.0 second update period, then Status Bit 12 *shall* be set to "0".
- e. If Ground Speed data in BDS 5,0 "MB" field bits 25 -through- 34 cannot be updated with valid data within the 1.0 second update period, then Status Bit 24 *shall* be set to "0".
- f. If Track Angle Rate data in BDS 5,0 "MB" field bits 36 -through- 45 cannot be updated with valid data within the 1.0 second update period, then Status Bit 35 *shall* be set to "0".
- g. If True Airspeed (TAS) data in BDS 5,0 "MB" field bits 47 -through- 56 cannot be updated with valid data within the 1.0 second update period, then Status Bit 46 *shall* be set to "0".

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Section 2.1, 2.1.1., and 2.1.2.a. Also same sections in Appendix B of this document.

3.6. BDS 5,F __ QUASI-STATIC PARAMETER MONITORING

3.6.1. PURPOSE AND DEFINITION

Appendix B, section 2.7.95 provides full definition of BDS 5,F.

The transponder *shall* comply with all constraints and requirements for servicing BDS 5,F that are expressed in Appendix B, section 2.7.95.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-95. and Appendix B, sec. 2.7.95 of this document.

3.6.2. ENHANCED SURVEILLANCE SERVICING REQUIREMENTS

3.6.2.1. REQUIRED SERVICING ASSOCIATED WITH BDS 5,F

- a. BDS 5,F bits 1,2 *shall* be set to "00" whenever MCP / FCU Selected Altitude data is not available to set bits 1 -through-13 of BDS 4,0.
- b. Whenever a change is detected in the MCP / FCU Selected Altitude data used to set bits 1 -through- 13 of BDS 4,0, the BDS 5,F bits 1,2 *shall* be incremented by one. Effectively, the decimal count is as follows: 1, 2, 3,--1, 2, 3, etc. The binary equivalent setting bits 1,2 is as follows: 01, 10, 11, -- 01, 10, 11, etc.
- c. BDS 5,F bits 21,22 *shall* be set to "00" whenever Static Air Temperature, Average Static Pressure, and Radio Height data is not available to set bits 16 -through- 51 of BDS 4,5.
- d. Whenever a change is detected in the Static Air Temperature, Average Static Pressure, and Radio Height data used to set bits 16 -through- 51 of BDS 4,5, the BDS 5,F bits 21,22 *shall* be incremented by one. Effectively, the decimal count is as follows: 1, 2, 3,--1, 2, 3, etc. The binary equivalent setting bits 21,22 is as follows: 01, 10, 11, -- 01, 10, 11, etc.
- e. BDS 5,F bits 23,24 *shall* be set to "00" whenever FMS Selected Altitude data (Target Altitude) is not available to set bits 14 -through- 26 of BDS 4,0.

- f. Whenever a change is detected in the FMS Selected Altitude data (Target Altitude) used to set bits **14** -through- **26** of BDS **4,0**, the BDS **5,F** bits **23,24** *shall* be incremented by one.
Effectively, the decimal count is as follows: **1, 2, 3,--1, 2, 3, etc.**
The binary equivalent setting bits **23,24** is as follows: **01, 10, 11, -- 01, 10, 11, etc.**

- g. BDS **5,F** bits **3** -through- **20** and **25** -through- **56** *shall* be set to "0" until such time that the respective parameters identified in Table 5,F are being monitored.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-95. and Appendix B, sec. 2.7.95 of this document.

3.6.3. MINIMUM UPDATE RATE OF BDS 5,F

- a. The minimum update rate at which BDS **5,F** *shall* be reloaded with valid data is **0.5** seconds.

That is, that BDS 5,F shall be updated at least once every 0.5 seconds.

- b. The time between availability of data that causes a change in BDS **5,F** and the time that the change is made to BDS **5,F** *shall* be less than the minimum update rate specified as **0.5** seconds.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Section 2.1, 2.1.1., and 2.1.2. Also same sections in Appendix B of this document.

3.7. BDS 6,0 __ HEADING AND SPEED REPORT

3.7.1. PURPOSE AND DEFINITION

Appendix B, section 2.7.96 provides full definition of BDS **6,0**. The same section provides full definition of the ARINC data words used to provide data for insertion into BDS **6,0**.

The transponder *shall* comply with all constraints and requirements for servicing BDS **6,0** that are expressed in Appendix B, section 2.7.96.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-96. and Appendix B, sec. 2.7.96 of this document.

3.7.2. BDS 6,0 DATA REQUIREMENTS

3.7.2.1. MAGNETIC HEADING

- a. The transponder *shall* process Magnetic Heading data from on-board aircraft data sources as provided in Appendix B, section 2.7.96, Note T-1 of the BDS **6,0** definition table and format the data into bits **2** -through- **12** of the BDS **6,0** "MB" field as shown in that table.
- b. The data loaded into the "MB" field *shall* be rounded so as to preserve accuracy of the source data within +/- 1/2 LSB.
- c. Status Bit **1** *shall* be set to "1" whenever valid data is available in bits **2** -through- **12**.
- d. Status Bit **1** *shall* be set to "0" whenever there is no valid data with which to fill bits **2** -through- **12**.
- e. Bits **2** -through- **12** *shall* be set to "0" whenever there is no valid data with which to fill the bits.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-96. and Appendix B, sec. 2.7.96 of this document.

3.7.2.2. INDICATED AIRSPEED

- a. The transponder *shall* process Indicated Airspeed data from on-board aircraft data sources as provided in Appendix B, section 2.7.96, Note T-2 of the BDS **6,0** definition

table and format the data into bits **14** -through- **23** of the BDS 6,0 "MB" field as shown in that table.

- b. The data loaded into the "MB" field *shall* be rounded so as to preserve accuracy of the source data within +/- 1/2 LSB.
- c. Status Bit **13** *shall* be set to "1" whenever valid data is available in bits **14** -through- **23**.
- d. Status Bit **13** *shall* be set to "0" whenever there is no valid data with which to fill bits **14** -through- **23**.
- e. Bits **14** -through- **23** *shall* be set to "0" whenever there is no valid data with which to fill the bits.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-96. and Appendix B, sec. 2.7.96 of this document.

3.7.2.3. MACH

- a. The transponder *shall* process Mach data from on-board aircraft data sources as provided in Appendix B, section 2.7.96 Note T-3 of the BDS 6,0 definition table and format the data into bits **25** -through- **34** of the BDS 6,0 "MB" field as shown in that table.
- b. The data loaded into the "MB" field *shall* be rounded so as to preserve accuracy of the source data within +/- 1/2 LSB.
- c. Status Bit **24** *shall* be set to "1" whenever valid data is available in bits **25** -through- **34**.
- d. Status Bit **24** *shall* be set to "0" whenever there is no valid data with which to fill bits **25** -through- **34**.
- e. Bits **25** -through- **34** *shall* be set to "0" whenever there is no valid data with which to fill the bits.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-96. and Appendix B, sec. 2.7.96 of this document.

3.7.2.4. BAROMETRIC ALTITUDE RATE

- a. The transponder *shall* process Barometric Altitude Rate data from on-board aircraft data sources as provided in Appendix B, section 2.7.96 Note T-4 of the BDS 6,0 definition table and format the data into bits **36** -through- **45** of the BDS 6,0 "MB" field as shown in that table.
- b. The data loaded into the "MB" field *shall* be rounded so as to preserve accuracy of the source data within +/- 1/2 LSB.
- c. Status Bit **35** *shall* be set to "1" whenever valid data is available in bits **36** -through- **45**.
- d. Status Bit **35** *shall* be set to "0" whenever there is no valid data with which to fill bits **36** -through- **45**.
- e. Bits **36** -through- **45** *shall* be set to "0" whenever there is no valid data with which to fill the bits.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-96. and Appendix B, sec. 2.7.96 of this document.

3.7.2.5. INERTIAL VERTICAL RATE

- a. The transponder *shall* process Inertial Vertical Rate data from on-board aircraft data sources as provided in Appendix B, section 2.7.96 Note T-5 of the BDS 6,0 definition table and format the data into bits **47** -through- **56** of the BDS 6,0 "MB" field as shown in that table.
- b. The data loaded into the "MB" field *shall* be rounded so as to preserve accuracy of the source data within +/- 1/2 LSB.
- c. Status Bit **46** *shall* be set to "1" whenever valid data is available in bits **47** -through- **56**.
- d. Status Bit **46** *shall* be set to "0" whenever there is no valid data with which to fill bits **47** -through- **56**.

- e. Bits **47** -through- **56** *shall* be set to "0" whenever there is no valid data with which to fill the bits.

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Table 2-96. and Appendix B, sec. 2.7.96 of this document.

3.7.3. MINIMUM UPDATE RATE OF BDS 6,0

- a. The minimum update rate at which BDS 6,0 *shall* be reloaded with valid data is 1.0 second.
That is, that BDS 6,0 shall be updated at least once every 1.0 second.
- b. The time between availability of data that causes a change in BDS 6,0 and the time that the change is made to BDS 6,0 *shall* be less than the minimum update rate specified as 1.0 seconds.
- c. If Magnetic Heading data in BDS 6,0 "MB" field bits **2** -through- **12** cannot be updated with valid data within the 1.0 second update period, then Status Bit **1** *shall* be set to "0".
- d. If Indicated Airspeed data in BDS 6,0 "MB" field bits **14** -through- **23** cannot be updated with valid data within the 1.0 second update period, then Status Bit **13** *shall* be set to "0".
- e. If Mach data in BDS 6,0 "MB" field bits **25** -through- **34** cannot be updated with valid data within the 1.0 second update period, then Status Bit **24** *shall* be set to "0".
- f. If Barometric Altitude Rate data in BDS 6,0 "MB" field bits **36** -through- **45** cannot be updated with valid data within the 1.0 second update period, then Status Bit **35** *shall* be set to "0".
- g. If Inertial Vertical Rate data in BDS 6,0 "MB" field bits **47** -through- **56** cannot be updated with valid data within the 1.0 second update period, then Status Bit **46** *shall* be set to "0".

REFERENCE: ICAO Annex 10, Volume III, Chapter 5, Appendix, Section 2.1, 2.1.1., and 2.1.2.2.2.1. Also same sections in Appendix B of this document.

3.8. FLIGHT IDENTIFICATION ECHO

3.8.1. BUSINESS AND REGIONAL SYSTEMS (BRS) TRANSPONDERS

The transponder *shall* echo each of the ARINC-429 Flight Identification Words (Label 233 -through- 237) (see section 2.3.3.1 of this appendix) received as discussed in section 2.3., as follows:

- a. Each Flight Identification Word received *shall* be transmitted via Data Output #1 (P2-15, 16) and Data Output #2 (P2-19, 20) at a minimum rate of once per second. The maximum rate *shall* be 5 per second.
- b. Each Flight Identification Word received *shall* be transmitted in the EXACT same format as it was received by the transponder.

3.9. ICAO 24-BIT ADDRESS ECHO

3.9.1. BUSINESS AND REGIONAL SYSTEMS (BRS) TRANSPONDERS

- a. The transponder currently provides the ICAO 24-Bit Address (Mode-S Address) to the TCAS Interface via the XTWORD-5, Label "275" and XTWORD-6, Label "276" defined in Note 1 and 2 below.
- b. The transponder **shall** provide XTWORD-5 and XTWORD 6 at all times (even if not interfaced to TCAS) as follows:
 - (1). Each of XTWORD-5, Label "275" and XTWORD-6, Label "276" **shall** be transmitted via the Data Output #1 (P2-15, 16) and Data Output #2 (P2-19, 20) at a minimum rate of once per second. The maximum rate **shall** be 5 per second.

Note 1: TRANSPONDER TO TCAS, TCAS CONTROL DATA (MODE-S ADDRESS PART 1 AND PART 2)

LABEL: 275
NAME: XTWORD-5
UPDATE RATE: 5/SECOND MINIMUM
 10/SECOND MAXIMUM
REFERENCE: ARINC-735A, Attachment 6P

LABEL-275 _ Bus 1, Word 5 _ Transponder to TCAS, TCAS Control Data (Mode-S Address Part 1)			
Bit #	Bit Designation	Bit #	Bit Designation
1	1 Label MSB	17	BIT A4
2	0	18	BIT A5
3	1	19	BIT A6
4	1	20	BIT A7
5	1 275	21	BIT A8
6	1	22	BIT A9
7	0	23	BIT A10
8	1 Label LSB	24	BIT A11
9	PAD	25	BIT A12
10	PAD	26	BIT A13
11	PAD	27	BIT A14
12	PAD	28	BIT A15
13	PAD	29	BIT A16 (LSB)
14	BIT A1 (MSB)	30	SSM
15	BIT A2	31	SSM
16	BIT A3	32	PARITY (ODD)

XTWORD-5 _ SSM CODE	
(Bits 31,30)	MEANING
00	VALID
01	NO COMPUTED DATA
10	FUNCTIONAL TEST
11	FAILURE WARNING

LABEL: 276
NAME: XTWORD-6
UPDATE RATE: 5/SECOND MINIMUM
 10/SECOND MAXIMUM
REFERENCE: ARINC-735A, Attachment 6Q

LABEL-276 Bus 1, Word 6 Transponder to TCAS, TCAS Control Data (Mode-S Address Part 2)			
Bit #	Bit Designation	Bit #	Bit Designation
1	1 Label MSB	17	BIT A21 ICAO 24 - BIT ADDRESS
2	0	18	BIT A22 PART 2
3	1	19	BIT A23 (MODE-S ADDRESS)
4	1	20	BIT A24 (LSB)
5	1 276	21	BIT A8 MAX AIRSPEED (MSB)
6	1	22	BIT A9 MAX AIRSPEED
7	1	23	BIT A10 MAX AIRSPEED
8	0 Label LSB	24	BIT A11 MAX AIRSPEED (LSB)
9	Aural Advisory Cancel (0 = Normal, 1 = Cancel)	25	PAD
10	RI ECHO	26	PAD
11	PAD	27	PAD
12	PAD	28	PAD
13	BIT A17 (MSB)	29	PAD
14	BIT A18	30	SSM
15	BIT A19	31	SSM
16	BIT A20	32	PARITY (ODD)

XTWORD-6__SSM CODE	
(Bits 31,30)	MEANING
00	VALID
01	NO COMPUTED DATA
10	FUNCTIONAL TEST
11	FAILURE WARNING

REFERENCE: DERIVED REQUIREMENT. REQUESTED BY BRS SYSTEMS

END OF APPENDIX C: ENHANCED SURVEILLANCE REQUIREMENTS